

CLAIMS

1. A tuning-fork type transducer for an angular-speed sensor comprising:

5 a tuning fork having two arms and a base portion for connecting the arms and being formed of non-piezoelectric material;

first piezoelectric films provided with upper electrodes thereof formed on a main surface of at least  
10 one arm out of two arms which excite the tuning fork in the X-axis direction thereof so as to be apart from each other with a center line thereof as a boundary; and

second piezoelectric films having upper electrodes formed on a main surface of at least one of the two arms  
15 so as to be apart from each other with the center line thereof as a boundary for monitoring amplitude of the arm in the X-axis direction when driving signals having the phases reversed from each other are supplied to the upper electrodes and hence the tuning-fork performs fork-  
20 oscillation in the X-axis direction with the center line thereof as a boundary, the upper electrodes outputting at least monitor signals having the phases reversed from each other.

25 2. The tuning-fork type transducer for an angular-

speed sensor of Claim 1, comprising:

the first piezoelectric films, the upper electrodes thereof and the lower electrodes thereof formed on the main surface of at least one of the two arms so as to be  
5 apart from each other with the center line thereof as a boundary; and

the second piezoelectric films, the upper electrodes thereof and the lower electrodes thereof formed on the main surface of at least one of the two arms so as to be  
10 apart from each other with the center line thereof as a boundary.

3. The tuning-fork type transducer for an angular-speed sensor of Claim 1, wherein the second piezoelectric  
15 films and the upper electrodes thereof are formed symmetrically with respect to the center line of the tuning-fork type angular-speed sensor as a boundary on one or the other one of the two arms.

20 4. The tuning-fork type transducer for an angular-speed sensor of Claim 1, wherein the first piezoelectric films, the upper electrodes thereof, and the lower electrodes thereof are formed on one of the two arms, and the second piezoelectric films, the upper electrodes  
25 thereof and the lower electrodes thereof are formed on the

other one of the two arms.

5. The tuning-fork type transducer for an angular-speed sensor of Claim 4, wherein a pair of the first  
5 piezoelectric films and the upper electrodes thereof are formed symmetrically on the one arm with respect to the center line as a boundary.

6. The tuning-fork type transducer for an angular-  
10 speed sensor of Claim 4, wherein a pair of the second piezoelectric films and the upper electrodes thereof are formed symmetrically on the one arm with respect to the center line as a boundary.

15 7. The tuning-fork type transducer for an angular-speed sensor of Claim 1, wherein the tuning fork is formed of silicon.

8. The tuning-fork type transducer for an angular-  
20 speed sensor of any one of Claims 1 to 3, wherein at least two electrodes out of the first piezoelectric films and the upper electrodes thereof, and the second piezoelectric films and the upper electrodes thereof are disposed from a center portion of the length of the arm in the Y-axis  
25 direction toward a proximal side thereof.

9. An angular-speed sensor comprising:

a tuning-fork type transducer for an angular-speed sensor;

5 a drive circuit; and

an angular-speed detection circuit,

the drive circuit including:

a first amplifier for amplifying signals acquired from the second piezoelectric films formed on the arm so as to be apart from each other with the center line thereof as a boundary, and the upper electrodes formed thereon respectively;

a differential amplifier for differentially amplifying the output signal from the first amplifier;

15 an AGC circuit to which an output signal from the differential amplifier is fed, and a second amplifier to which an output signal from the AGC circuit is fed; and

a second amplifier supplying driving signals having the phases reversed from each other are supplied to the respective upper electrodes formed on the first piezoelectric films formed on the arm so as to be apart from each other with the center line thereof as a boundary,

the angular-speed detection circuit including:

an adder in which either one of respective signals acquired from the first amplifier or respective signals

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acquired from the first piezoelectric films formed on the arm bent in the Z-axis direction of the arm so as to be apart from each other with the center line as a boundary and the upper electrodes formed thereon are added;

5       a phase shifter for shifting the phase of the output signal from the adder; and

          a synchronous demodulator for synchronously demodulating the output signal from the phase shifter on the basis of the output signal from the first amplifier or  
10   the output signal from the differential amplifier.

10. An angular-speed sensor comprising:

      a tuning-fork type transducer for an angular-speed sensor;

15       a drive circuit; and  
      an angular-speed detection circuit,  
      the drive circuit including:

      a first amplifier for amplifying signals acquired from the second piezoelectric films formed on the arm so  
20   as to be apart from each other with the center line thereof as a boundary, and the upper electrodes formed thereon respectively;

      a first differential amplifier for differentially amplifying the output signal from the first amplifier;

25       an AGC circuit to which an output signal from the

first differential amplifier is fed, and a second amplifier to which an output signal from the AGC circuit is fed; and

5 a second amplifier supplying driving signals having the phases reversed from each other are supplied to the respective upper electrodes formed on the first piezoelectric films formed on the arm so as to be apart from each other with the center line thereof as a boundary,

the angular-speed detection circuit including:

10 a first adder in which the respective signals acquired from the first amplifier is added;

a third amplifier for amplifying respective signals acquired from the first piezoelectric films and the upper electrodes formed thereon;

15 a second adder for adding signals amplified by the third amplifier;

a second differential amplifier for differentially amplifying the added signal obtained by being added in the second adder;

20 a phase shifter for shifting the phase of the output signal from the second differential amplifier; and

a synchronous demodulator for synchronously demodulating the output signal from the phase sifter by the output signal from the first amplifier or the output  
25 signal from the first differential amplifier.

11. An automotive vehicle comprising the angular-  
speed sensor of Claim 9 or Claim 10 as a sensor for  
detecting at least any one of yaw rate, rolling and  
5 pitching.